

**Army/NASA Rotorcraft Division**

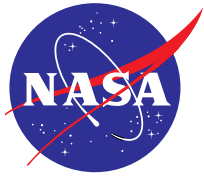


# **Man-Machine Integration Design and Analysis System: MIDAS**

---

**Barry Lakinsmith, Chief  
Flight Control and Cockpit Integration Branch  
Army/NASA Rotorcraft Division  
Ames Research Center  
Aeroflightdynamics Directorate  
Aviation RDEC**

**[www-midas.arc.nasa.gov](http://www-midas.arc.nasa.gov)**



# **MIDAS Applications**

---

## **NASA:**

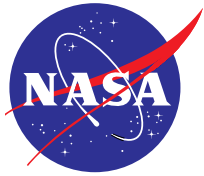
**Advanced Air Traffic Technologies  
High Speed Research Program**

## **Army:**

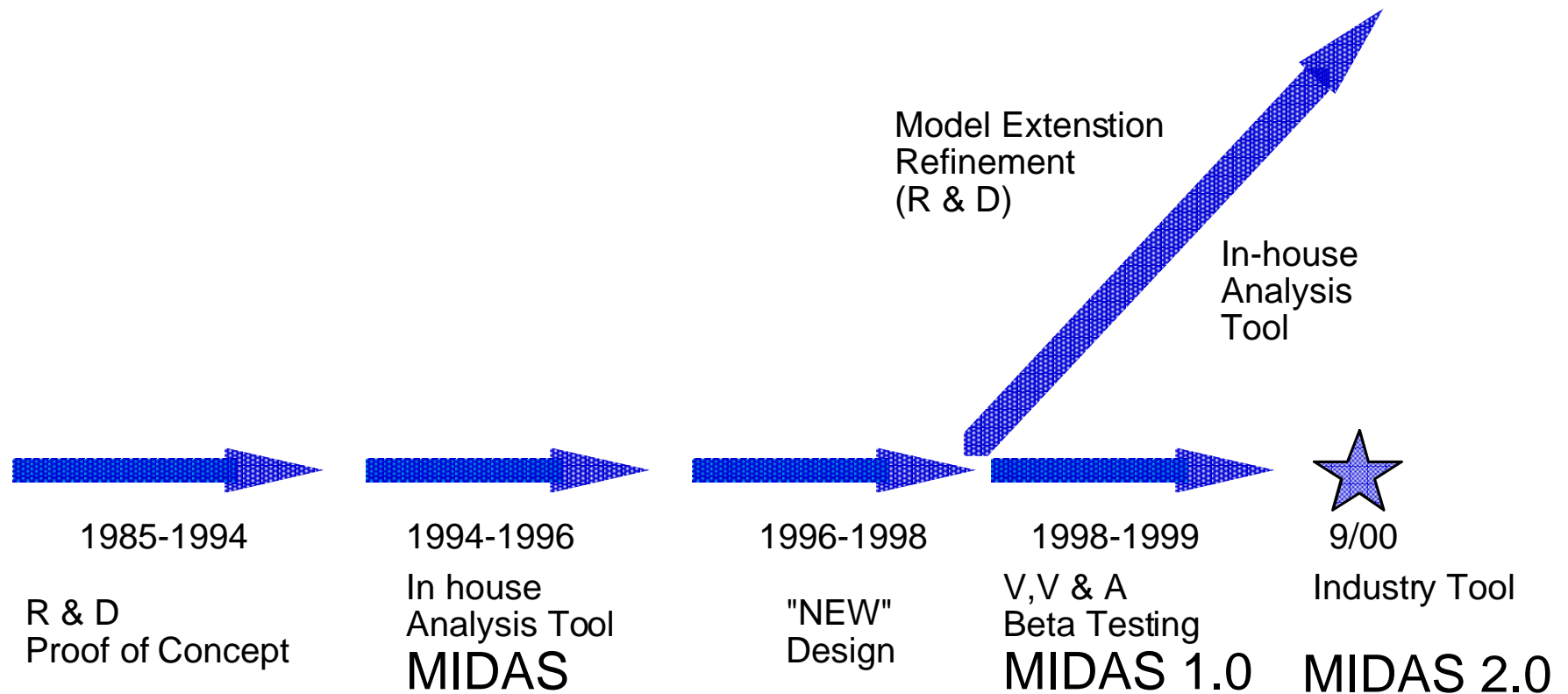
**AirWarrior  
CH-47**

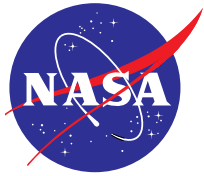
## **Other:**

**Nuclear Power Plant  
911**



# MIDAS Development Schedule





## **Why Redesign ?**

---

### **Implementation:**

**3 languages (C, C++, LISP)**

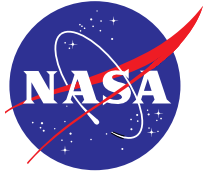
**500k lines of code**

**250k MIDAS**

**250k Jack® (U of Penn, Transom)**

**Legacy Code**

**User Interface**



## **Why Redesign ?**

---

### **Functionality:**

**Difficult to use**

**Multiple Operators**

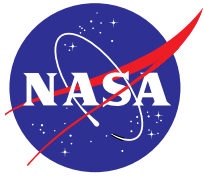
**Long Term Memory (LTM), working memory distinction**

**Reactive Action Packages (RAPs)**

**Multiple Resource Attention Model**

**Internal and External Vision**

**Audition**



# **MIDAS Models**

---

## **Perception:**

**Vision**

**Audition**

## **Central Processing and Memory:**

**Attention**

**Working Memory**

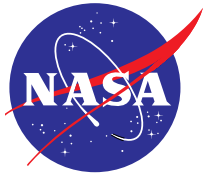
**Long Term Memory**

**(Reactive Action Packages)**

## **Process Models:**

**Workload**

**Situational Awareness**



## Perception: Vision

---

### External

Peripheral = 160 degrees

Foveal = 2.5 degrees

Perception level f(dwelling time, perceivability)

Perceivability f(visibility, size, distance, local contrast ratio)

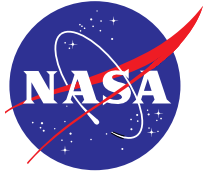
Levels of Perception = detection, recognition, identification

### Internal

Symbolic (check read)

Digital (exact value)

Text (character string)



# **Perception: Audition**

---

## **Two Stages of Processing:**

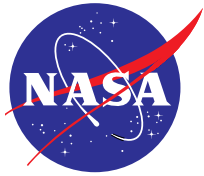
- 1) Detection**
- 2) Comprehension**

**Content: verbal strings or signals**

**All or none processing -- partial processing  
planned (semantic parsing)**

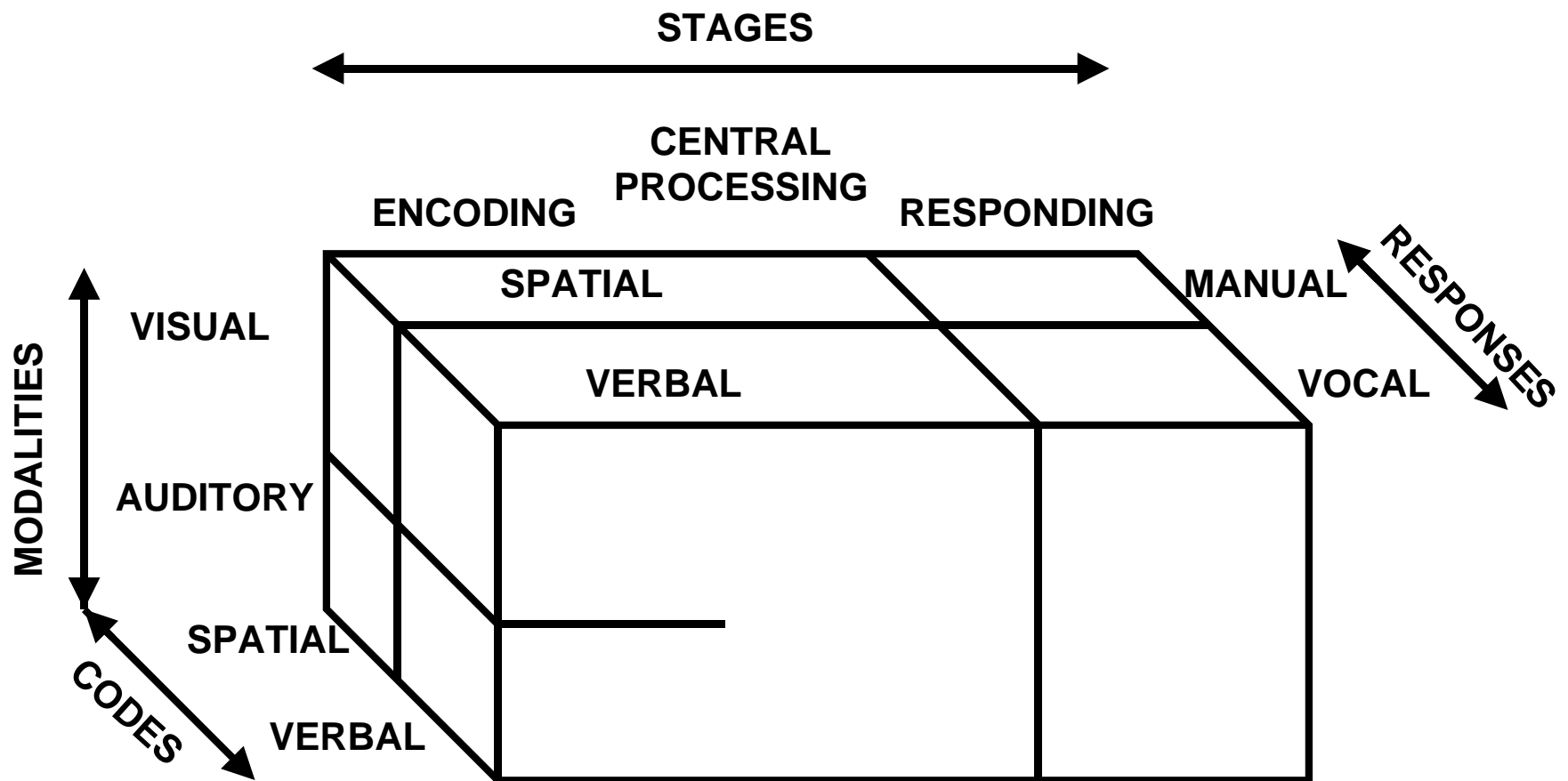
**Interrupts currently disrupts entire message**

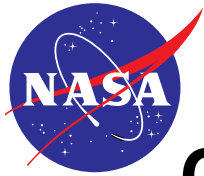




# Central Processing and Memory: Attention

## Wickens, 1980 Multiple Resource Theory





# **Central Processing and Memory: Working Memory**

---

## **Contains:**

**a) Current Context --**

**Instantiated by sensory input**

**Used to select RAPs from LTM**

**b) Task Agenda --**

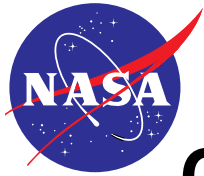
**Contains currently active goals**

## **Manages:**

**a) New Events**

**b) Goal Priorities**

**c) Plan Execution**

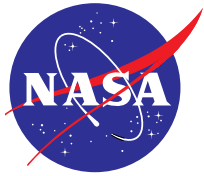


# **Central Processing and Memory: Long Term Memory**

---

**Declarative Knowledge:  
Expertise, Facts**

**Procedural Knowledge:  
Reactive Action Packages (Firby, 1989)  
RAP Library**



# **Reactive Action Packages: RAPs**

---

**RAPs are based on “sketchy” planning.**

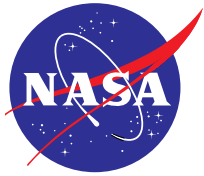
**Current Context (working memory) --> LTM**

**Current Context (n) = RAP Context(n)**

**RAP Context(n) contains:**

**procedures for task execution**

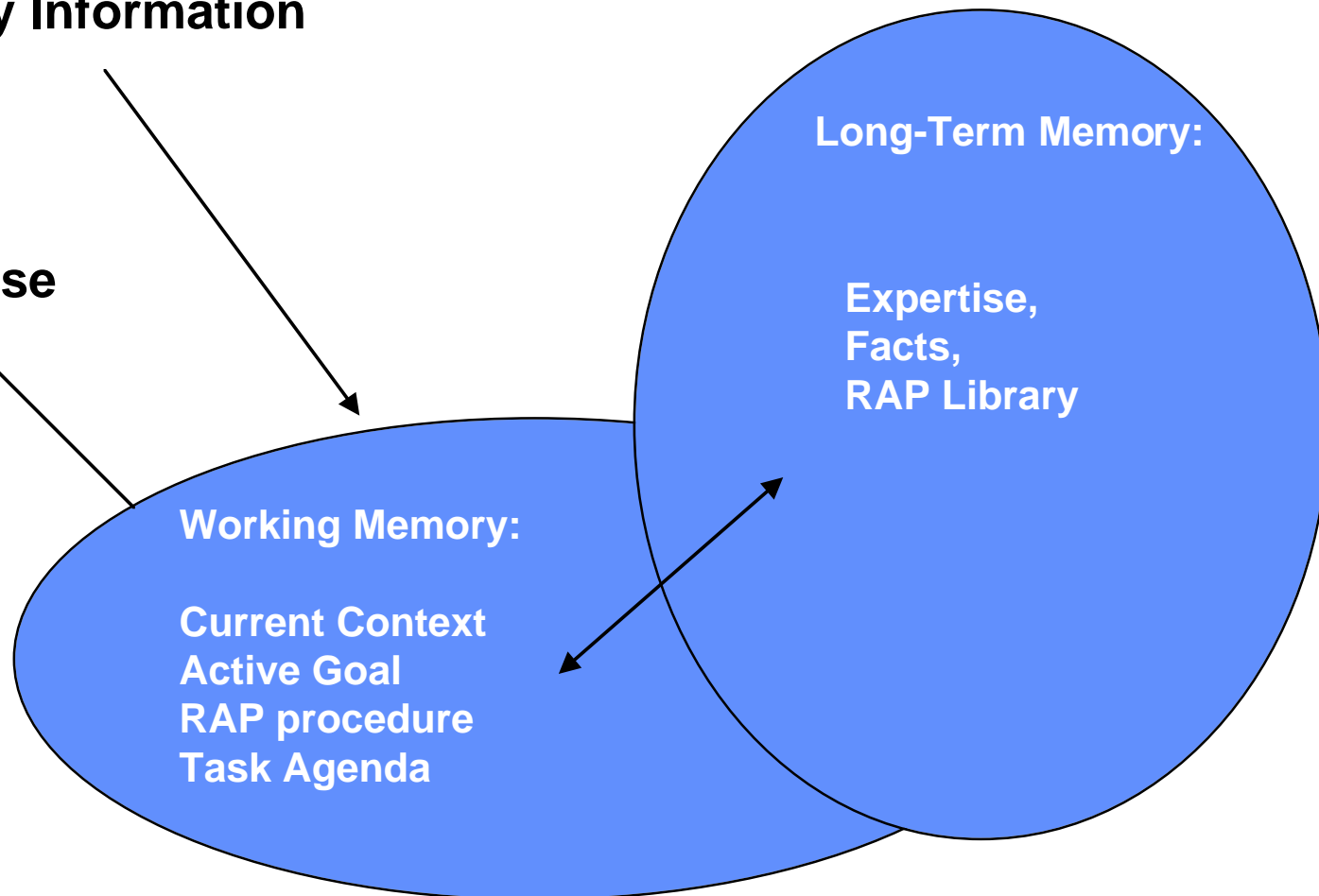
**success criteria for completion**

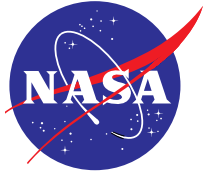


# RAP Example

## Sensory Information

**Motor  
Response**





## Key Difference Functionality

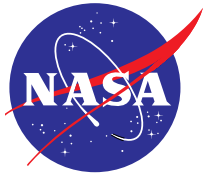
---

### Old MIDAS:

Behavior is controlled by top-down goal decomposition. Specify conditionals in detail.

### New Design:

Behavior is controlled by an interaction of top-down goals and environmentally driven contexts. Conditionals don't need to be specified, but **emerge** as behaviors.



# **Process Models**

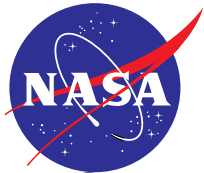
---

**Workload (McCracken and Aldrich, 1988)**

**Visual, Auditory, Cognitive, Psychomotor  
1-7 Scale based on Task Primitives**

**Situational Awareness (Shively, Brickner &  
Silbiger, 1997)**

**Situational Elements  
Context-Sensitive Higher Order Nodes**



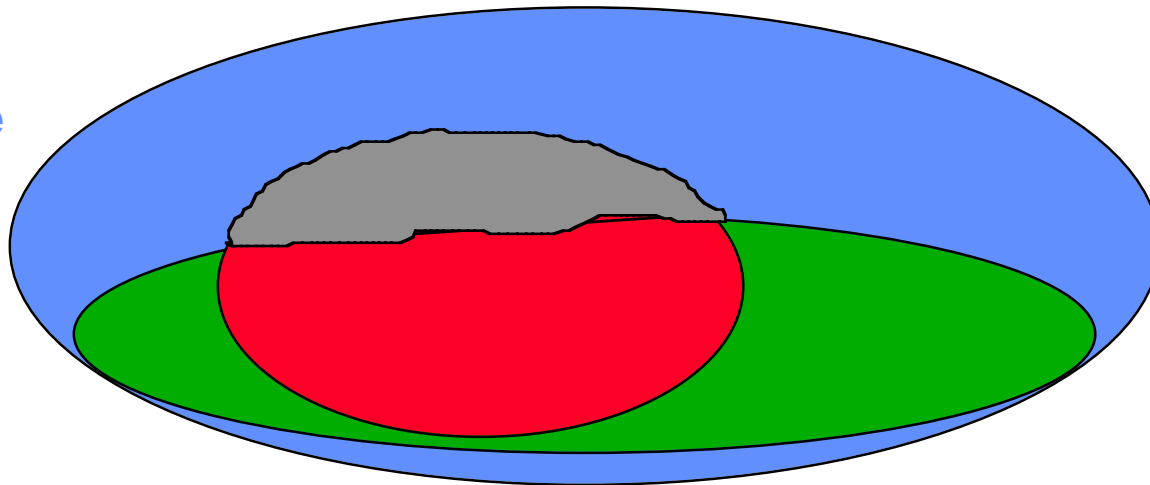
## Situational Awareness (Shively, Brickner & Silbiger)

Ratio of *relevant* knowledge that the user has to the *relevant* information needed

operator know (context)

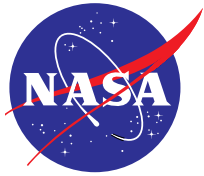
info needed (context)

World State



Operator Info  
(non-relevant)





## **Plans**

---

**Alpha Release - Sept 30, 1998**

**Beta Release - Dec 31, 1998**

**Boeing - Philadelphia**

**Israel Air Force**

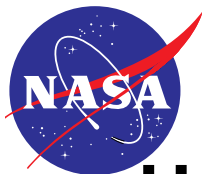
**Validation - thru Dec 31, 1999**

**Blue Ribbon Panel - Spring, 1999**

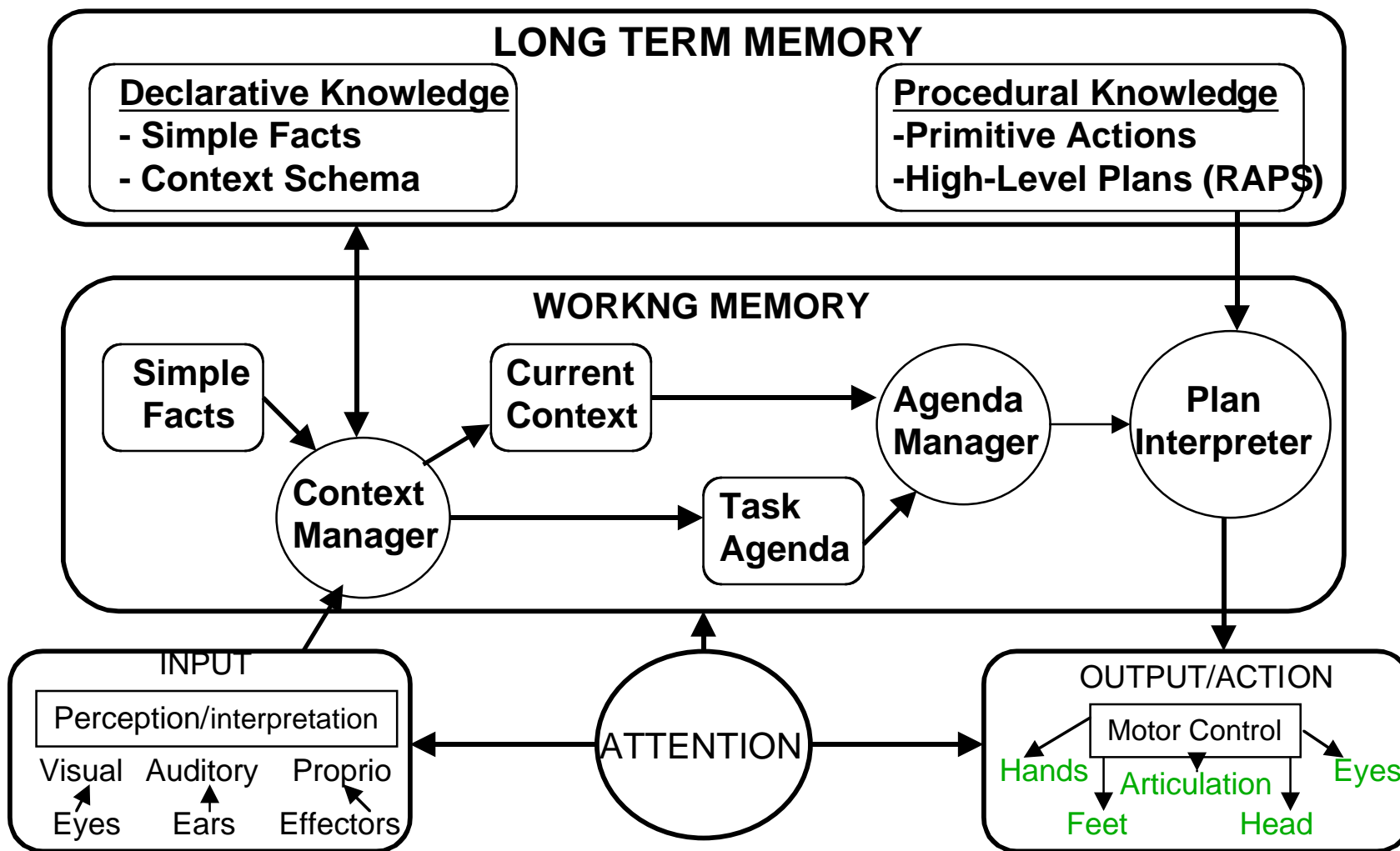
**Empirical Validation -**

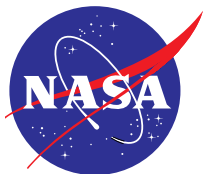
**Usability Testing -**

**Industry Release - Sept 30, 2000**



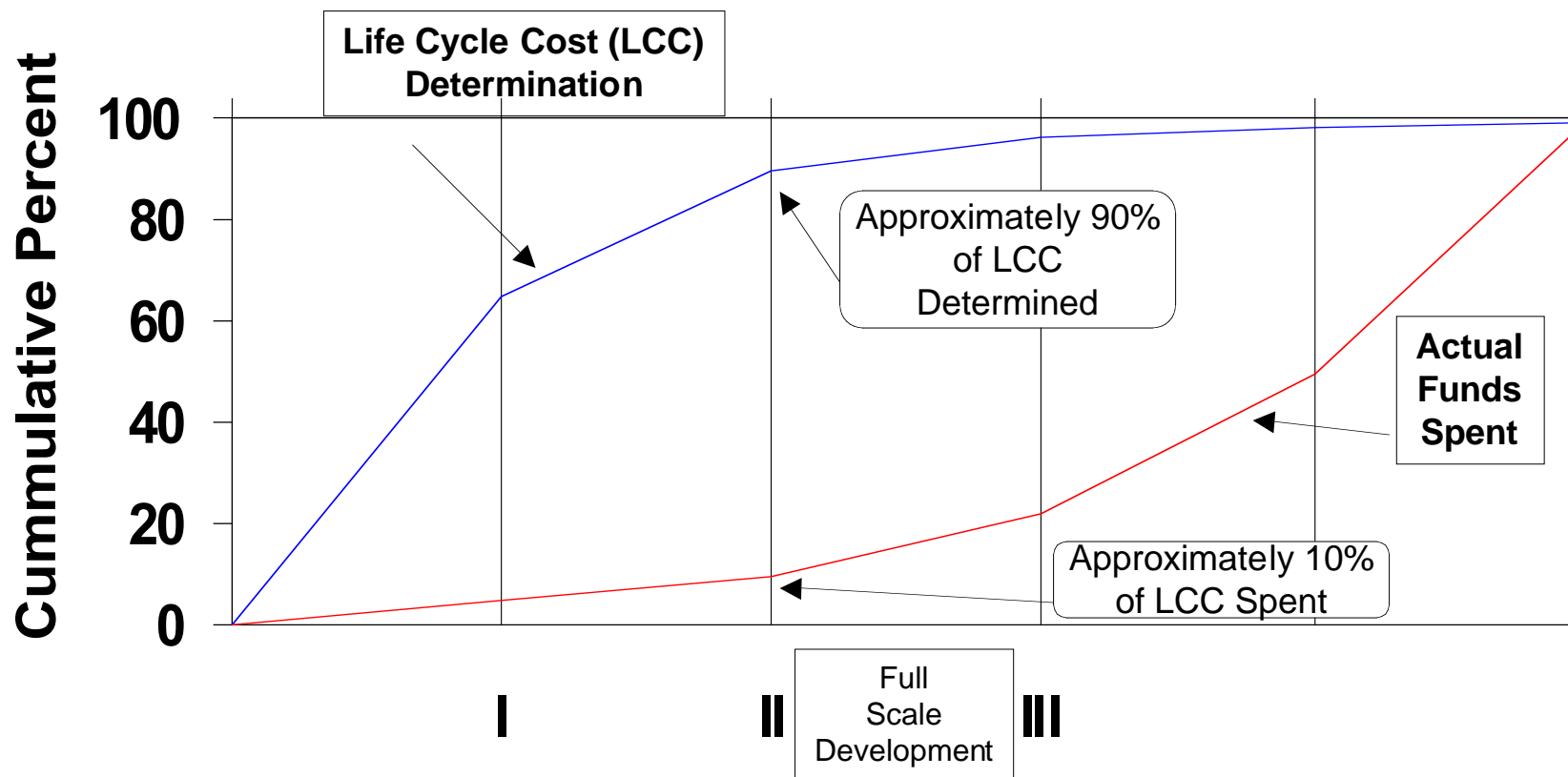
# Human Performance Model: Overview

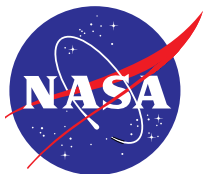




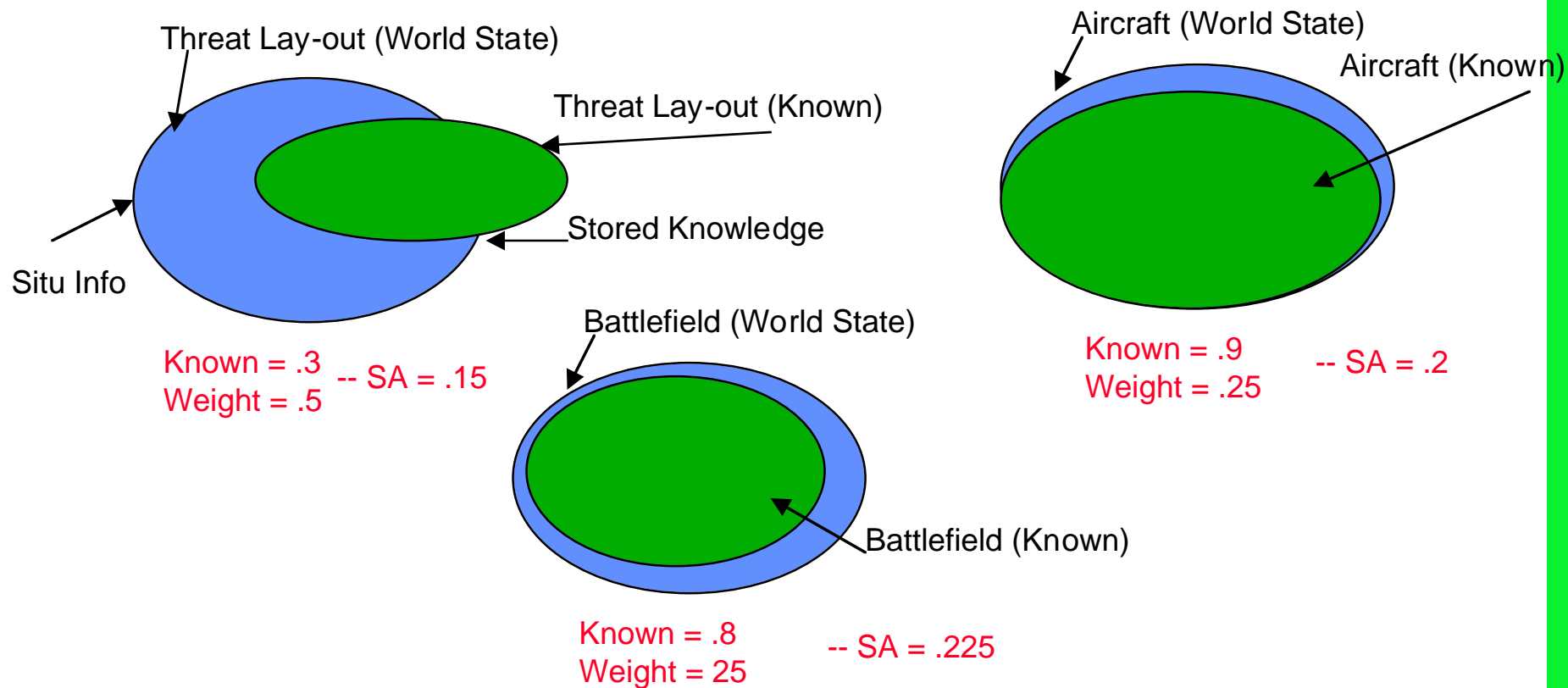
# Life Cycle Cost Leverage Defense Systems

**Acquisition Community is Focused on  
Cost Reduction Throughout Life Cycle**

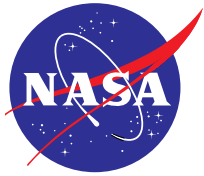




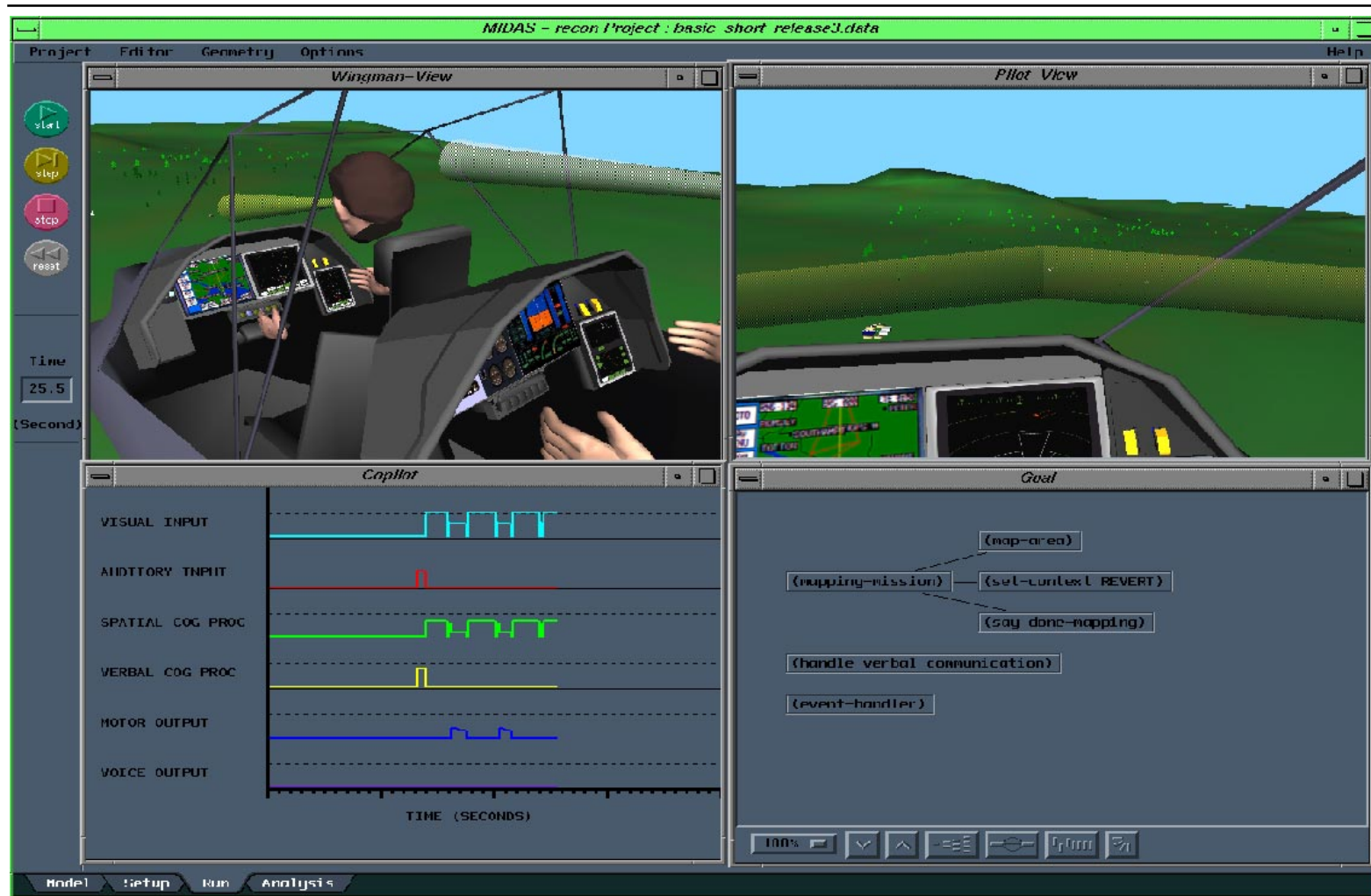
# SA Example

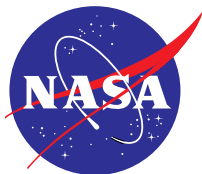


$$\text{TOTAL SA} = .15 + .225 + .2 = .575$$

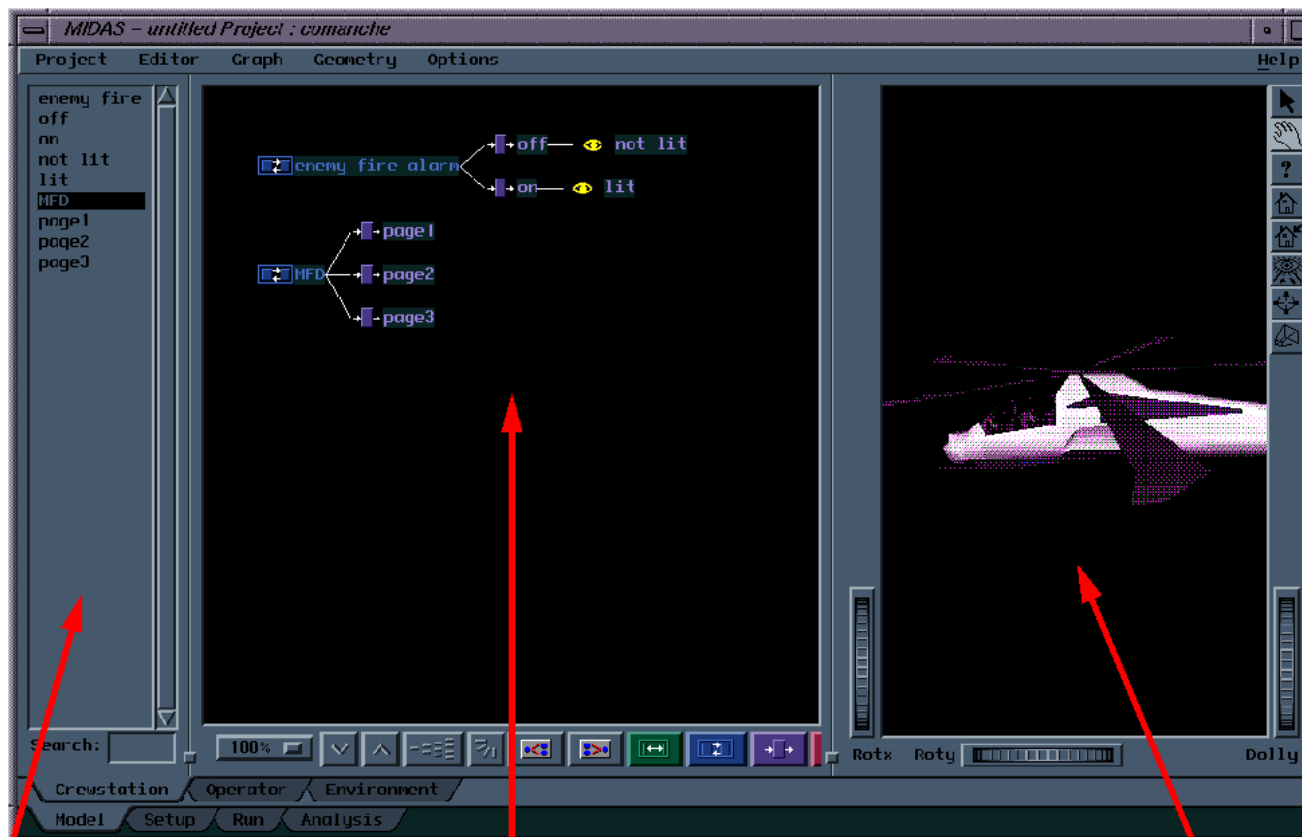


# Run-time Display - GUI





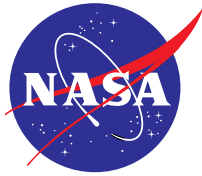
# Crewstation Editor - GUI



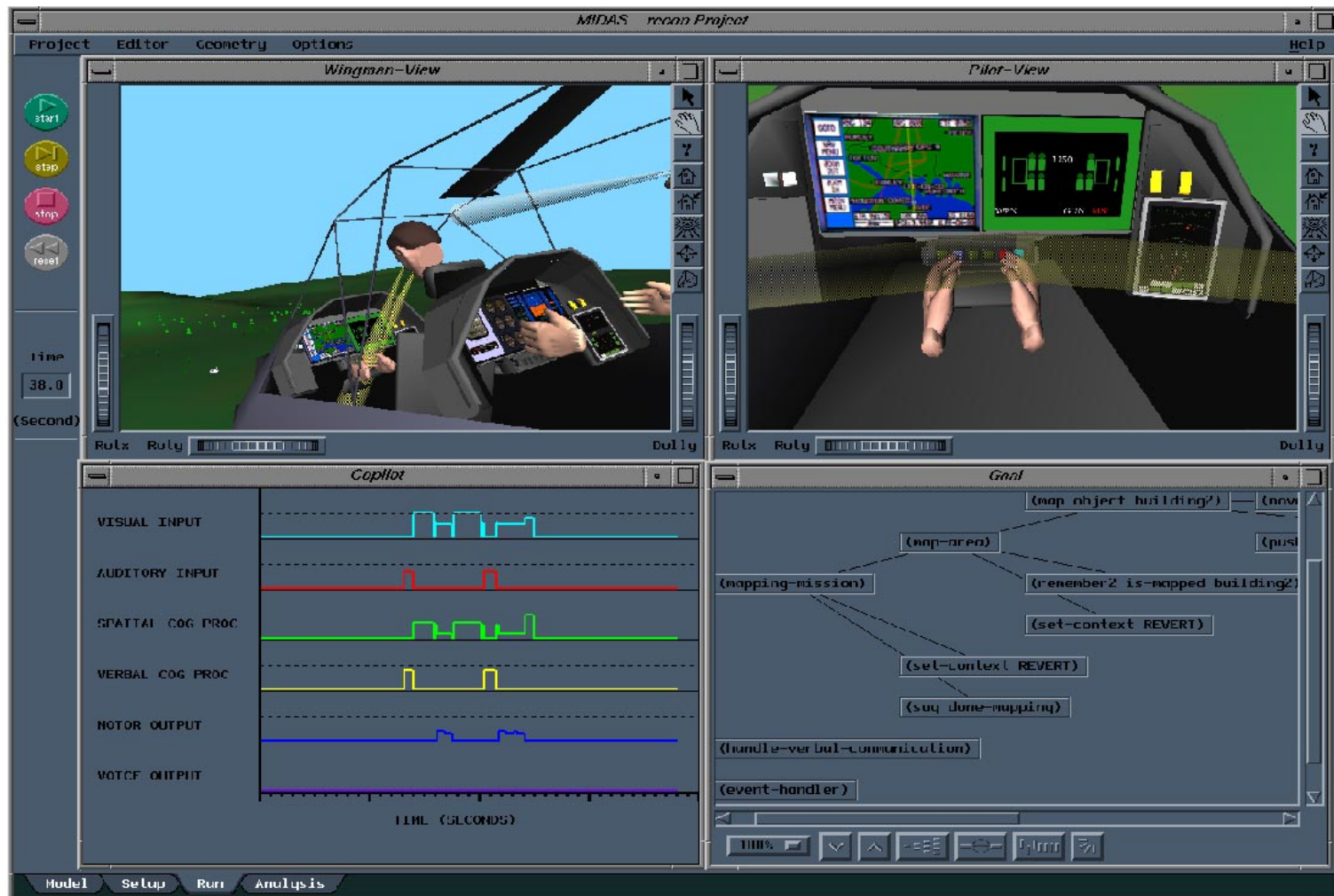
Outline View

Structure View

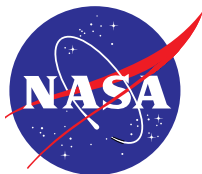
Geometry View



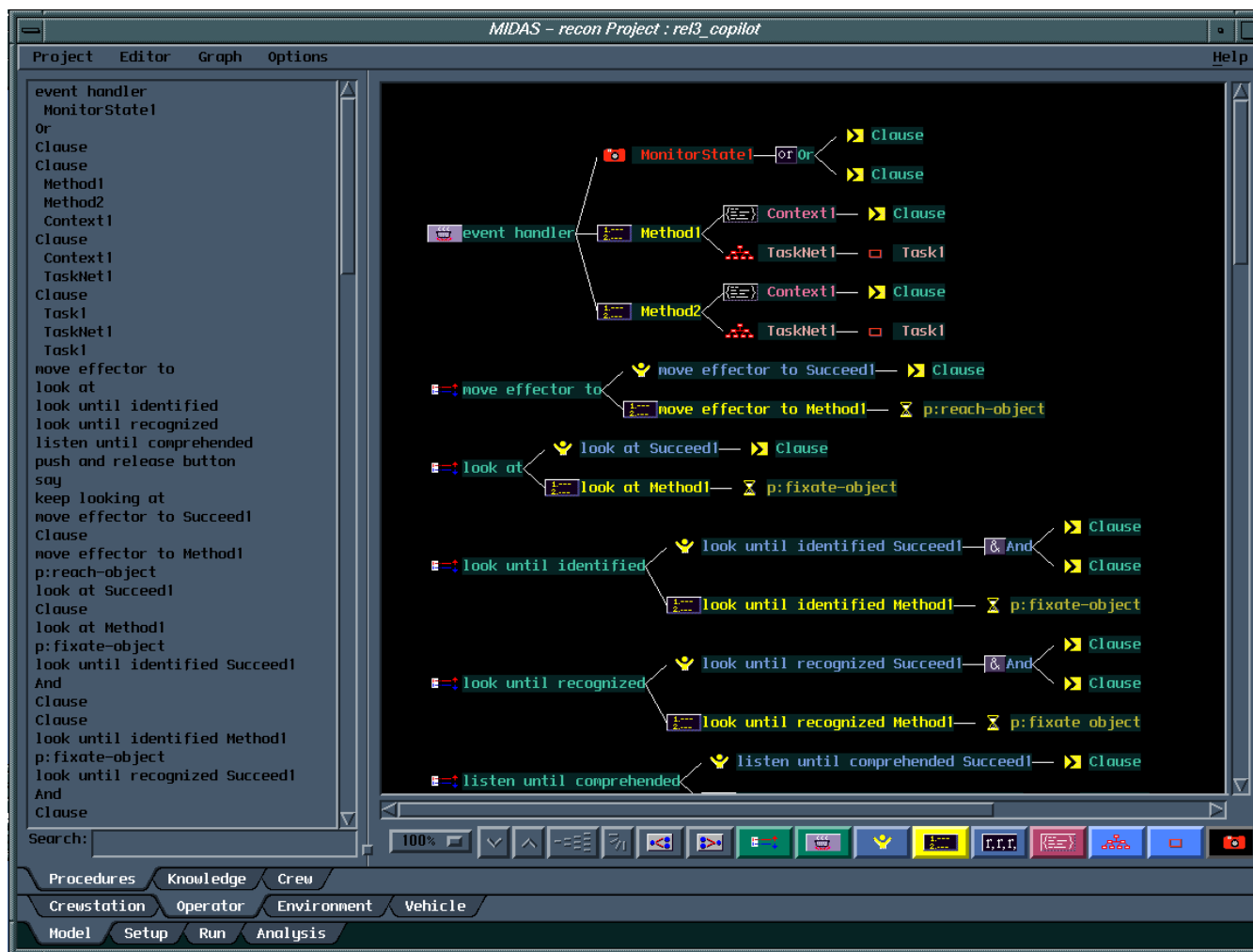
# Run-time Display - Co-pilot - GUI



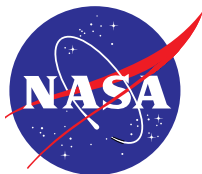




# Procedure Editor - GUI







# Tab Format for GUI Editors

